

CLAIMS

What is claimed is:

1. A functionalized nanoparticle comprising:
 - a) a nanoparticle coated with a monolayer comprising a capture coating component;
 - b) a bifunctional protein having a first binding domain and a second binding domain, the first and second binding domains each comprising a member of a binding pair; wherein the bifunctional protein is affixed to the nanoparticle of (a) at the first binding domain.
2. A functionalized nanoparticle of Claim 1 wherein the nanoparticle is metallic.
3. A functionalized nanoparticle according to Claim 2 wherein the metal comprising the nanoparticle is selected from the group consisting of gold, silver, platinum, palladium, iridium, rhodium, osmium, iron, copper, cobalt, and alloys thereof.
4. A functionalized nanoparticle of Claim 1 wherein the nanoparticle is a semiconductor.
5. A functionalized nanoparticle according to Claim 4 wherein the semiconductor comprising the nanoparticle is selected from the group consisting of cadmium selenide, cadmium sulfide, silver sulfide, cadmium sulfide, zinc sulfide, zinc selenide, lead sulfide, gallium arsenide, silicon, tin oxide, iron oxide, and indium phosphide.
6. A functionalized nanoparticle according to Claim 1 wherein said monolayer is selected from the group consisting of:
 - a) molecules having reactive groups selected from the group consisting of: $-NH_2$, $-COOH$, $-CHO$, $-OH$, $-X$ (Cl, Br, I), succinimide, and epoxy groups; and
 - b) biomolecules selected from the group consisting of: peptides; tiopronin and GSH.
7. A functionalized nanoparticle according to Claim 1 wherein said monolayer further comprises a shielding component.
8. A functionalized nanoparticle according to Claim 7 wherein the shielding component is selected from the group consisting of: short chain ethylene glycol oligomers, ethylene glycol methacrylate, sugars, crown ethers, and acrylamide.

9. A functionalized nanoparticle according to Claim 1 wherein said first binding domain comprises a member of a binding pair selected from the group consisting of: Glutathione-S-transferase/glutathione, 6X Histidine Tag/Ni-NTA, Streptavidin/biotin, S-protein/S-peptide,
5 Cutinase/phosphonate inhibitor, antigen/antibody, hapten/anti-hapten, folic acid/folate binding protein, and protein A or G/immunoglobulins.

10. A functionalized nanoparticle according to Claim 1 wherein said second binding domain is a nucleic acid binding amino acid sequence.

11. A functionalized nanoparticle according to Claim 10 wherein
10 said nucleic acid binding amino acid sequence is selected from the group consisting of DNA binding domains, and RNA binding domains.

12. A functionalized nanoparticle according to Claim 11 wherein said nucleic acid binding amino acid sequence is described by the citations selected from the group consisting of: Genbank accession
15 number: NP_417816, Genbank accession number: P03040, Genbank accession number: NP_040628, Genbank accession number: NP_059642, Genbank accession number: NP_059641.

13. A functionalized nanoparticle according to Claim 10 wherein the nucleic acid binding amino acid sequence is a DNA binding zinc finger
20 sequence.

14. A functionalized nanoparticle according to Claim 13 wherein the zinc finger sequence binds to a target sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2 and SEQ ID NO:3

15. A functionalized nanoparticle according to Claim 1 wherein said
25 second binding domain has affinity for capture moieties selected from the group consisting of nucleic acids, peptides, biological cells, and inorganic nanotubes

16. A functionalized nanoparticle according to Claim 15 wherein the second binding domain of the bifunctional peptide has affinity for a carbon
30 nanotube.

17. A functionalized nanoparticle according to Claim 16 wherein the bifunctional peptide comprises an amino acid sequence having carbon nanotube binding affinity selected from the group consisting of SEQ ID
NO's 4-27.

35 18. A method for capturing a capture moiety comprising contacting a capture moiety selected from the group consisting of nucleic acids,

peptides, biological cells, and inorganic nanotubes with the functionalized nanoparticle of Claim 1.

19. A method according to Claim 18 wherein the functionalized nanoparticle comprises:

- 5 a) a nanoparticle coated with a monolayer comprising a capture coating component;
- b) a bifunctional protein having a first binding domain and a second binding domain, the first binding domain comprising a member of a binding pair, the second
- 10 binding domain comprising a nucleic acid binding amino acid sequence;

wherein the bifunctional protein is affixed to the nanoparticle of (a) through the first binding domain.

20. A method according to Claim 19 wherein the capture moiety is

15 a nucleic acid.

21. A method according to Claim 19 wherein the nucleic acid binding amino acid sequence is a DNA binding zinc finger sequence.

22. A method according to Claim 19 wherein the zinc finger sequence binds to a target sequence selected from the group consisting

20 of SEQ ID NO:1, SEQ ID NO:2 and SEQ ID NO:3.

23. A nucleic acid nanoparticle complex comprising:

- a) a nanoparticle coated with a monolayer comprising a capture coating component;
- 25 b) a bifunctional protein having a first binding domain and a second binding domain, the first binding domain comprising a member of a binding pair, the second binding domain comprising a nucleic acid binding amino acid sequence;

wherein the bifunctional protein is affixed to the nanoparticle of

30 (a) through the first binding domain and is affixed to a nucleic acid fragment at nucleic acid binding amino acid sequence.

24. A nucleic acid nanoparticle complex according to Claim 23 wherein the nucleic acid fragment is immobilized on a solid support.

25. A nucleic acid nanoparticle complex according to Claim 23

35 wherein the nucleic acid binding amino acid sequence is a zinc finger.

26. A process for immobilizing a multiplicity of nanoparticles on a nucleic acid matrix comprising:

- 5 a) providing a multiplicity of functionalized nanoparticles,
 each comprising:
 i) a nanoparticle coated with a monolayer comprising a
 capture coating component;
 ii) a bifunctional protein having a first binding domain
 and a second binding domain, the first binding domain
 comprising a member of a binding pair, the second
 binding domain comprising a nucleic acid binding
 amino acid sequence;
 wherein the bifunctional protein is affixed to the
 metallic nanoparticle through the first binding domain
 and wherein the nucleic acid binding amino acid
 sequence of each second binding domain is unique;
 b) providing a nucleic acid matrix having peptide binding
 domains having affinity for the nucleic acid binding amino
 acid sequence of each second binding domain of each
 bifunctional peptide of (a);
 c) contacting the functionalized nanoparticles of (a) with the
 nucleic acid matrix of (b) under conditions whereby the
 nucleic acid binding amino acid sequence of the
 bifunctional peptide bind to peptide binding domains of the
 nucleic acid matrix of (b) to immobilize the nanoparticles.
- 10 27. A nanometer scale electronic device made by the process of
 Claim 26.
- 15 28. A nanometer scale electronic device of Claim 27 selected from
 the group consisting of an electronic heterojunction, an electronic
 interconnect and a nano-wire.
- 20 29. A functionalized carbon nanotube comprising:
 a) a carbon nanotube; and
 b) a bifunctional protein having a first binding domain and a
 second binding domain, the first binding domain having
 affinity for a carbon nanotube and the second binding
 domain comprising a member of a binding pair;
 wherein the bifunctional protein is affixed to the carbon
 nanotube of (a) through the first binding domain.
- 25 30 35

30. A functionalized carbon nanotube according to Claim 29 wherein said second binding domain is a nucleic acid binding amino acid sequence.

5 31. A functionalized nanoparticle according to Claim 30 wherein said nucleic acid binding amino acid sequence is selected from the group consisting of DNA binding domains, and RNA binding domains.

32. A functionalized nanoparticle according to Claim 31 wherein said nucleic acid binding amino acid sequence is described by the citations selected from the group consisting of Genbank accession
10 number: NP_417816, Genbank accession number: P03040, Genbank accession number: NP_040628, Genbank accession number: NP_059642, Genbank accession number: NP_059641.

33. A functionalized carbon nanotube according to Claim 31 wherein the nucleic acid binding amino acid sequence is a DNA binding
15 zinc finger sequence.

34. A functionalized carbon nanotube according to Claim 33 wherein the zinc finger sequence binds to a target sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2 and SEQ ID NO:3.